

CONTENTS

Introduction.....	4
1.1 Motivation.....	4
1.2 Objectives.....	5
1.3 Organization of the report.....	5
Theoretical Background and Literature Review	7
2.1 Brain Computer Interface	7
2.1.1 Signal Acquisition Unit	8
2.1.2 Motor Imagery (MI)	9
2.2 Review of other similar projects	17
2.2.1 F. Quandt et al.....	17
2.2.2 Ke Liao et al.	18
2.3 Background Study	19
2.3.1 Machine Learning: Uses and Types.....	27
2.3.2 Theory and Working Principle of SVM	31
Proposed Architecture for.....	37
Experimentation	37
3.1 EEG signal acquisition unit	38
3.2 Feature Extraction unit.....	38
3.3 Feature Selection unit	38
3.4 Classification unit.....	38
Background Experiments	39
4.1 Understanding the BCI Dataset.....	39
Technical data.....	39
Format of the data	39
4.2 Bispectrum Analysis	39
4.3 Statistical features.....	43

4.4 The Support Vector Machine	43
4.3.1 Training and Testing	43
4.3.2 Parameter Setting in SVM	44
4.3.3 Experiments on single channel	47
4.3.4 Experimentation for Correlation among features	48
4.5 Band Pass Filter on Statistical Features	49
4.6 Accuracies of Reduced Feature Set.....	51
Conclusion and Future Work.....	53
5.1 Conclusion.....	53
5.2 Future Work and Discussion	54
References	1

List of Figures

2.1	A typical BCI architecture	8
2.2	Different cortex regions of the brain	10
2.3	Typical Sodium Potassium pump	11
2.4	International 10-20 System	12
2.5	Delta wave	13
2.6	Theta wave	14
2.7	Alpha wave	14
2.8	Mu or Sensorimotor wave	15
2.9	Beta wave	15
2.10	Gamma wave	15
2.11	Feature Selection Process	20
2.12	Filter Approach for Feature Selection	21
2.13	Wrapper Approach to Feature Subset Selection	22
2.14	3-fold Cross-Validation for Accuracy Estimation	23
2.15	Steps for Feature Selection	25
2.16	Supervised Learning Model	27
2.17	Unsupervised Learning Model	28
2.18	A typical Confusion Matrix	30
2.19	Linear SVM Classification	31
2.20	Non-linear SVM Classification	31
2.21	K-fold Cross Validation	35
3.1	Proposed Architecture	36
4.1	Bispectrum C3 for Left hand	40
4.2	Bispectrum C3 for Right hand	40
4.3	Bispectrum C4 for Left hand	41
4.4	Bispectrum C4 for Right hand	41
4.5	Grid search for C and Gamma	44

4.6 Confusion Matrix for Channel C3.....	45
4.7 Confusion Matrix for Channel C4.....	45

List of Tables

- 2.1 Cortical areas of the brain and their functions 10
- 4.1 Classification accuracy based on crude feature 43
- 4.2 Selection of C and Gamma 44
- 4.3 Experiments on C3 only 46
- 4.4 Experiments on C4 only 47
- 4.5 Correlation Coefficient between feature pairs 48
- 4.6 Classification Accuracies on Two Channels 49
- 4.7 Classification Accuracies on Single Channel 50
- 4.8 Accuracies of Reduced Feature Set 51